

## Fractional Snowcover Estimates from Earth Observing System (EOS) Terra and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS)

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The Moderate Resolution Imaging Spectroradiometer (MODIS) on the NASA Earth Observing System (EOS) Terra and Aqua missions has shown considerable capability for mapping snowcover. The typical approach that has used, along with other criteria, the Normalized Snow Difference Index (NDSI) that takes the difference between 500 meter observations at 1.64 micrometers (MODIS band 6) and 0.555 micrometers (MODIS band 4) over the sum of these observations to determine whether MODIS pixels are snowcovered or not in mapping the extent of snowcover. For many hydrological and climate studies using remote sensing of snowcover, it is desirable to assess if the MODIS snowcover observations could not be enhanced by providing the fraction of snowcover in each MODIS observation (pixel). Pursuant to this objective studies have been conducted to assess whether there is sufficient „signal% in the NDSI parameter to provide useful estimates of fractional snowcover in each MODIS 500 meter pixel. To accomplish this objective high spatial resolution (30 meter) Landsat snowcover observations were used and co-registered with MODIS 500 meter pixels. The NDSI approach was used to assess whether a Landsat pixel was or was not snowcovered. Then the number of snowcovered Landsat pixels within a MODIS pixel was used to determine the fraction of snowcover within each MODIS pixel. These results were then used to develop statistical relationships between the NDSI value for each 500 meter MODIS pixel and the fraction of snowcover in the MODIS pixel. Such studies were conducted for three widely different areas covered by Landsat scenes in Alaska, Russia, and the Quebec Province in Canada. The statistical relationships indicate that a 10 percent accuracy can be attained. The variability in the statistical relationships for the three areas was found to be remarkably similar ( $\sim 0.02$  for mean error and less than 0.01 for mean absolute error and standard deviation). Independent tests of the relationships were accomplished by taking the relationship of fractional snow-cover to NDSI from one area (e.g., Alaska) and testing it on the other two areas (e.g. Russia and Quebec). Again the results showed that fractional snow-cover can be estimated to 10 percent. The results have been shown to have advantages over other published fractional snow-cover algorithms applied to MODIS data. Most recently the fractional snow-cover algorithm has been applied using 500-meter observations over the state of Colorado for a period spanning 25 days. The results exhibit good behavior in mapping the spatial and temporal variability in snow-cover over that 25-day period. Overall these studies indicate that robust estimates of fractional snow-cover can be attained using the NDSI parameter over areas extending in size from watersheds relatively large compared to MODIS pixels to global land cover. Other refinements to this approach as well as different approaches are being examined for mapping fractional snow-cover using MODIS observations.

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